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FEED-DISPERSION SYSTEM FOR FLUID CATALYTIC CRACKING UNITS AND PROCESS FOR FLUID CATALYTIC CRACKING

Abstract:

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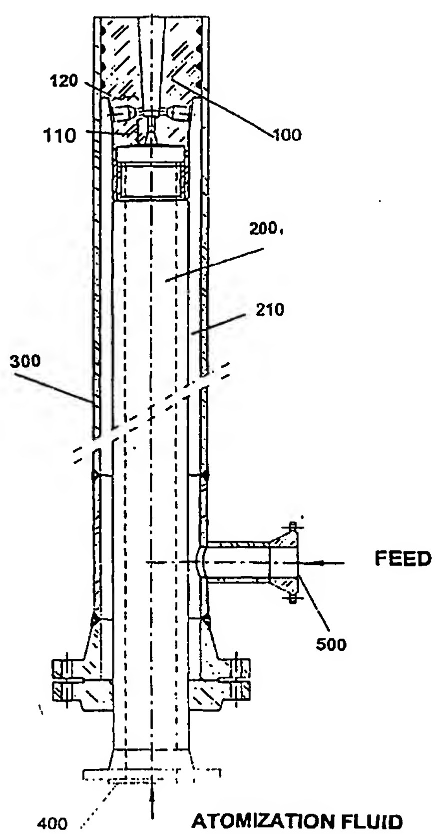

(57) Abstract: A feed-dispersion system for hydrocarbon feeds of fluid catalytic cracking units is described, which comprises: a feed-injection system made up of two concentric conduits, where the atomization fluid flows through the inner conduit (200), while the liquid feed flows through the annular space (210) formed by the outer surface of the inner conduit and the inner surface of the outer conduit; an atomization unit (100) having nozzles arranged in rows, with one row having central nozzles (110) connected to the inner conduit for atomization fluid, and two or more rows of side nozzles (120), connected to the outer feed conduit, the central nozzles (110) and side nozzles (120) of the atomization unit being geometrically placed so that the energy of the atomization fluid is fully transferred by contact to the flow of feed, this resulting in the complete atomization of the feed; a mixing chamber (101) formed by the edges of the central nozzles, the dimensions of which are able to prevent the coalescence of the formed oil droplets.

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FEED-DISPERSION SYSTEM FOR FLUID CATALYTIC CRACKING UNITS AND PROCESS FOR FLUID CATALYTIC CRACKING

FIELD OF THE INVENTION

The present invention relates to a feed-dispersion system for the optimized dispersion of hydrocarbon stocks as feeds for catalytic cracking units (FCC), more specifically, to a feed-dispersion system able to promote the full atomization of a hydrocarbon feed, said system comprising a unique geometrical arrangement so that the energy transferred from the atomizing fluid to the hydrocarbon feed is fully used for the feed atomization. The invention relates further to the FCC process that uses the feed-dispersion system of the invention.

BACKGROUND INFORMATION

Fluid catalytic cracking (FCC) is a main process for obtaining highly ranked petroleum related products, such as gasoline, diesel oil (DO) and liquid petroleum gas (LPG), from heavy feeds having usable light fractions. The feeds most often submitted to the FCC process are generally those refinery streams that have their origin in side cuts of vacuum towers, called heavy vacuum gasoil, or heavier streams that find origin in the bottom of atmospheric towers called atmospheric residue or even a mixture of those streams.

Such streams, when submitted to the FCC process, are contacted with a catalyst made up of a fine particulate material in a conversion zone in the absence of hydrogen and are converted into lighter and more valuable hydrocarbon streams, separated from streams that are even heavier than the feed.

In spite of the fact that the FCC process is more than 50 years old, techniques that might improve the process are continuously sought, increasing the yield in products of higher intrinsic value. Generally, it is agreed that the main goal of the FCC processes is the maximization of the production of higher intrinsic value products

One relevant aspect of the process is the initial contact of the catalyst with the feed; that is, the interaction promoted by the dispersion system has a marked influence on the conversion and selectivity to valuable products.

A few trials aiming at improving the contact between the catalyst and the feed have been carried out, always based on the idea of promoting a quick vaporization of the feed as well as an intimate contact with the catalyst during the small period of time available within the riser. In order to process the catalytic cracking reactions it is required that the vaporization of the feed in the area of mixture with the catalyst occurs within a few milliseconds so that the molecules of the vaporized hydrocarbons may contact the catalyst particles, permeating through the catalyst macropores and suffering the effect of the acid sites that promote the catalytic cracking. If a quick vaporization does not occur, the result is a thermal cracking of the still liquid fractions.

It is well known that the thermal cracking leads to the formation of by-products such as coke and fuel gas, mainly in the case of residuum-containing charges. Therefore, the thermal cracking on the riser bottom undesirably competes with the catalytic cracking that is the object of the FCC process.

One important parameter for the feed atomization is its temperature in the atomizer. Some of its physical properties such as viscosity and surface tension are altered as a function of temperature and during the atomization process result in a universe of lower diameter droplets. Therefore a substantial increase in the contact area by the surfaces of the droplets present in the spray occurs, this entailing a significant impact on the ease of vaporization. For residual feeds used in the FCC process and at the recommended temperature ranges, it may be demonstrated that the increase in contact area by using higher feed temperatures can be 30%. However the feed temperature cannot be indefinitely increased since there is the risk of coke build up and non-selective thermal cracking within the feed furnaces.

On the other hand the quick vaporization of the feed will be obtained more easily if the feed is suitably atomized, so as to form a thin spray on the catalyst phase. In order to obtain that spray several models of feed injectors in the riser have been developed.

According to one of the first of such developments, the feed and the steam were added to the catalyst from the regenerator with the aid of a Y tube, in a system known as "Y jet', which in practical terms does not properly disperse the feed, leaving to the hot catalyst the transfer of heat to the feed and the subsequent vaporization. This model was acceptable for lighter feeds where the

vaporization caused by the heat transferred by the catalyst was practically instantaneous.

Since the 1980s, with the advent of heavier feeds from heavier oils in the FCC units, several modifications were introduced in the feed injection system. One such change has been the replacement of the so called single feed-dispersion system by the multiple feed-dispersion system, placed at elevations between 30° and 70°, at one or more levels, so as to provide a better feed dispersion as well as a better contact with the catalyst. The standard flat spray was at first widely used for this purpose.

Other kinds of feed-dispersion systems have been developed concomitant to the increase in the severity of the feeds to be cracked.

US 4,434,049 teaches the atomization of a water/oil emulsion by a feed-dispersion system the feature of which is the modification of the size of the oil particles by the impact of the emulsified feed against a flat cylindrical surface. According to the authors, the feed-dispersion system produces a spray having oil particles of about 500 microns diameter that are then accelerated by the steam entering by a spot perpendicular to the feed inlet. The inlet rate of steam causes the oil particles to be submitted to shear forces, this rendering such particles still smaller; the mixture of steam and emulsified feed is then accelerated up to an outlet nozzle having a special geometry so as to obtain the feed dispersed as a fine spray. However, the described device requires that the feed be introduced as an emulsion with water so that the surface tension is reduced, and then the water/oil micelles are broken by the impact against the flat cylindrical surface.

European patent EP 0,546,739 relates also to a device for feed injection that uses the principle of breaking oil particles through the collision with a flat surface, without however requiring the previous emulsification of the oil with water.

Brazilian PI BR 8404755 teaches a feed-injection device where the feed and the atomizing fluid (steam) are admixed within a chamber in order to promote the dispersion of the feed in an efficient way. The mixing chamber bears a central pin the diameter of which controls the flow rates in the annular space. The atomizing fluid, distributed through several holes, enters

perpendicularly to the feed. A mist is then formed that is directed to the interior of the riser.

US 5,037,616 (corresponding to EP 0,312,428) teaches that a good dispersion of the feed with vapor may be obtained with the aid of a feed injector using a venturi tube. Dimensions characterize the geometry of this device such that the speed of the feed and steam mixture reaches sonic conditions at the venturi throat. On its turn, the venturi tube has a cylindrical internal section and is situated between converging and diverging sections. The continuity of converging, cylindrical and diverging sections is smoothly made by means of a curved section. The superior angle of the device with the venturi tube is around 5° to 15° and the diameter of an exit hole is at most 2 to 5 times the venturi tube diameter. On average, oil droplets having diameters of the order of 10 to 50 microns are formed, and are injected in the riser at speeds of the order of 60 to 150 meters by second.

US 5,173,175 teaches a device for feed injection into a fluid catalytic cracking reaction zone, the device comprising a straight section where the feed and steam are pre-mixed and a terminal section where oil is atomized and dispersed by means of a fan-like distributor. The feed injector yields a flat vaporization standard that is perpendicular to the catalyst flow direction in the contact section between the catalyst and the oil in the cracking zone. It is reported that better product yield and less coke and gas are produced. The system described in this US patent works so that the fluids are admixed prior to the element that promotes the feed atomization and causes the fan-like jet formation. On the contrary, the present application proposes that the fluids are admixed on the bottom of the device that promotes the atomization and the formation of the fan-like flat jet. The atomization is promoted by the efficient contact between the steam from the atomizing fluid nozzle (the fluid being generally steam) and the charge nozzles that surround the atomizing nozzle.

Besides, the working condition described in US 5,173,175 as well as in all documents where the technique employs the premixing of the feed and the atomization fluid causes the following feature linked to the loss of charge (or ΔP to conform to the widespread jargon). The premixing causes a loss of charge in the interior of the riser where the charge jet and atomizing fluid is admixed to the catalyst, this loss of charge being shared by both the charge and atomizing

fluid. Common charge loss implies that a considerable portion of the energy of the atomization fluid is not used for promoting the atomization.

US 5,673,859 teaches a vaporization nozzle for fluid catalytic cracking that shows two discharge orifices elongated in the cross direction to effect a fine atomization of the liquid hydrocarbon charge as said charge is vaporized by the nozzle. Preferably the orifices are inclined so as to produce a convergent spray but may be inclined to produce a divergent spray or a substantially flat spray. The basic principle of said system is to use the dissipation of kinetic energy of the charge through the inelastic shock with a metal bar (referenced 13) to promote atomization. Thus, to obtain good atomization a high pressure upstream of the device referenced 15 is required. Due to the reduction in kinetic energy with the square of feed flow rate, by working with reduced feed flow rates the atomization performance would be seriously jeopardized. On the contrary, in the present application this effect does not exist since the atomization energy is substantially independent of the charge flow rate.

US patent 5,794,857 corresponding to PI BR 9607665-8A, teaches a device for feed injection mounted with two concentric conduits where the inner conduit is the steam conduit and the outer conduit is the feed conduit, so that both conduits define an annular liquid conduit for the feed. The outlet end of the inner conduit is semi-spherical and has a row comprising a plurality of holes therein for the passage of the steam; the also semi-spherical outlet end of the outer conduit has an elongated slit parallel to the orifices of the semi-spherical outlet of the inner conduit for passage of steam and feed as a spray. It is reported that the device allows for the operation at low steam pressure, or even in the absence of steam in case any problem occurs caused by the refinery steam feed. Contrary to the technique taught in this US patent, in the present application the energy of the atomization fluid is transformed in a more efficient way using a converging section having a variable converging angle so as to make an efficient conversion of the atomization fluid pressure into kinetic energy and to promote the feed atomization. The contact of the feed with the atomization fluid is carried out by means of nozzles that direct the contact of the feed with steam so that the generated kinetic energy is transmitted to the feed, instantaneous and intense atomization being promoted.

Therefore, the purpose of the present invention is not taught or suggested. There is provided a feed-dispersion system whose geometry is able to promote the atomization of the feed so that the average diameter of the oil particles is about 100 microns, with the improved use of the transfer of the atomization fluid energy to the feed. This way, a better performance of the process and the catalytic cracking fluid unit is made possible.

SUMMARY OF THE INVENTION

The present invention comprises a feed-dispersion system for liquid hydrocarbon feeds of FCC units.

Accordingly, there is provided a feed dispersion system for fluid catalytic cracking units (FCC) for introducing a liquid hydrocarbon feed to a reactor for fluid catalytic cracking, the system comprising:

a feed injection system for supplying hydrocarbon feed to a first nozzle system and for supplying atomization fluid to a second nozzle system;

an atomizing unit for atomizing said hydrocarbon feed with an atomization fluid, said atomizing unit comprising said first and second nozzle systems geometrically arranged to discharge into a mixing chamber so that the energy of said atomization fluid is transferred to said hydrocarbon feed.

There is further provided a method of atomizing a hydrocarbon feed comprising:

supplying hydrocarbon feed to a first nozzle system;

supplying atomization fluid to a second nozzle system;

accelerating the flow of atomization fluid into a mixing chamber using said second nozzle system;

accelerating the flow of hydrocarbon feed into a mixing chamber using said first nozzle system;

mixing said accelerated flows so as to transfer energy from said atomization fluid to said hydrocarbon feed and thereby atomize said hydrocarbon feed.

In a preferred embodiment, the present invention comprises a feed-dispersion system for FCC units having the following characteristic features:

- a feed-injection system made up of two concentric conduits of substantially circular section, where the atomization fluid flows through the inner conduit,

while the liquid feed flows through the annular space formed by the outer surface of the inner conduit and the inner surface of the outer conduit;

- an atomization unit having a row comprising a plurality of nozzles, with one row having central nozzles connected to the inner conduit for atomization fluid, the symmetry axis of the nozzles being parallel or not to the symmetry axis of the inner/outer conduits, and two or more side nozzles, connected to the outer feed conduit, the symmetry axis of said side nozzles being or not parallel to the symmetry axis of the conduits; while in this unit:
  - the central and side nozzles are geometrically placed so that the energy of the atomization fluid is optimally transferred by contact to the flow of feed with the result of the complete atomization of the feed;
  - a mixing chamber is formed by combining the discharge zones of the central nozzles, said chamber being the geometrical locus formed by the sequence of free surfaces downstream each contact spot of the atomization fluid and the liquid feed, said chamber having dimensions able to prevent the coalescence of the formed oil droplets.

The feed injection system of the invention is designed to be radially coupled by 2, 4, 6 or more units to the riser of a conventional fluid catalytic cracking unit.

The feed-dispersion system of the invention may be coupled to one, two or more levels of the riser, at an elevation angle between 30 and 70°, according to the needs of the fluid catalytic cracking process.

The present invention provides a feed-dispersion system able to atomize the feed by the efficient use of the energy of the atomization fluid. Besides, it keeps its excellent performance for a wide range of operating conditions.

The present invention provides also a feed-dispersion system that yields a mist of atomized feed having an average droplet diameter small enough for an improved interaction with the catalyst grains.

The present invention provides an atomization unit having an arrangement of the outlet nozzles that makes if possible to operate with a ratio of feed nozzles to atomization fluid nozzles equal to or higher than 1.

The present invention provides further a feed-dispersion system that makes possible a better conversion of the feed into valuable products such as gasoline and naphtha.

The present invention provides a feed-dispersion system whose construction allows lower feed losses and consequently lowers pumping powers of the hydrocarbon feed flow.

The present invention provides further a higher-conversion FCC process, with improved yields in valuable products and lower yields in coke and gas as a consequence of the use of the feed-dispersion system of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be further described, by way of non-limitative example only, with reference to the accompanying schematic drawings, in which:-

FIGURE 1 shows a longitudinal cross-sectional view of a feed-dispersion system according to the present invention, with the inlet flanges, conduits for carrying fluids and the atomization unit;

FIGURE 2A is a longitudinal cross-sectional view of the atomization unit;

FIGURE 2B is a top view of the atomization unit;

FIGURE 3 is a longitudinal cross-sectional view at 90° to the view of FIGURE 2A;

FIGURE 4A and FIGURE 4B show longitudinal cross-sectional views of respectively curved and straight mixing chambers of the atomization unit according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention relates to a feed-dispersion system for feeds of catalytic cracking units (FCC) aiming at obtaining the finely atomized feed so as to attain a better contact between the feed and the regenerated catalyst. In this way the thermal cracking reactions as well as the formation of coke and fuel gas are minimized. Consequently, the yield in valuable products is maximized.

The present invention is directed to any kind of feed, but more preferably to heavy feeds, such as heavy gasoils and the mixtures of gasoils and atmospheric residue, for example.

The atomizing fluid is any inert gas such as nitrogen, fuel gas or steam, for example, medium or low-pressure steam usually produced in the refinery, steam being preferred in view of its low cost and availability.

The invention will now be described in more detail with reference to the attached FIGURES.

FIGURE 1 illustrates a cut along the longitudinal axis of the feed dispersing system that is the object of the present invention, herein represented by a drawing according to the Brazilian Standard ABNT NBR 10647. The system is made up of an outer conduit (300) and inner conduit (200), annular space (210), atomization fluid inlet (400) and hydrocarbon liquid feed inlet (500), along with an atomization unit (100) that partially enters the interior of the riser (not represented) of the FCC unit. The atomization unit (100) has central nozzles (110) for atomization fluid and side nozzles (120) for liquid feed.

The concentric conduit system conveys the atomization fluid and the liquid feed up to the atomization unit (100) where the flows of atomization fluid and liquid feed will encounter each other. The relative arrangement of the central and side nozzles will cause the complete atomization of the feed while promoting the optimized interaction with the catalyst present in the riser. The contact with the finely atomized feed and the hot regenerated catalyst promotes the vaporization of the liquid feed this contributing in large part for the improved performance of the FCC unit.

The pre-heated feed for the FCC unit is conveyed via the annular space (210) created between the inner wall of the outer conduit (300) and the outer wall of the inner conduit (200), while the inner conduit (200) conveys the atomization fluid, normally steam. The amount of atomization fluid employed varies of from 1 to 5 weight % based on the feed, more preferably of from 2 to 4 weight %, even for heavy and viscous feeds or having a high content of carbon residue.

The mixing between the liquid feed and the atomization fluid occurs in the atomization unit (100), the geometry of which plays a major role in the complete atomization of the feed, such as described and claimed in the present invention.

As shown in FIGURE 1, the pre-heated liquid feed is introduced in the dispersing system through flange (500) and conveyed through the annular space (210) formed by conduits (200) and (300). The flow of feed reaches the side nozzles (120) in order to be placed, through the discharge orifice of said nozzles, in a collision path with the jet of atomization fluid from the central nozzles (110). Thus in the system of the invention the side nozzles (120)

represent the only exit for the flow of liquid feed conveyed through the annular space (210).

FIGURES 2A and 2B illustrate the atomization unit (100) of one of the preferred modes of the present invention. FIGURE 2A is a longitudinal cross-sectional view and FIGURE 2B is a top view showing the orifices of three atomization fluid nozzles (110). Such nozzles (110) aim to accelerate the flow of the atomization fluid. This number of nozzles, in this case 3 nozzles, was adopted only as an example, and may be higher or lower and may even be one single nozzle, this aspect not being intended to limit the invention.

The atomization fluid is introduced into the injection feed system through flange (400) and conveyed through the inner conduit (200), eventually reaching an antechamber (103) formed by the space between the tip of the inner conduit (200) and the inlets (111) of the central nozzles (110) of atomization fluid. Such nozzles (110) may be parallel or not to the longitudinal axis of the feed injection system. Thus, in the described system the central nozzles (110) are the only exit for the atomization fluid out of the conduit (200).

Nozzles (110) accelerate and place the flow of atomization fluid towards mixing chamber (101) described hereinbefore.

The shape of the antechamber (103) is not critical, and may vary widely, without affecting the performance of the feed injection system.

In FIGURE 3 the atomization unit (100) is shown in detail by means of a cut in a longitudinal cross-section rotated 90 degrees from the view of FIGURE 2A.

The central nozzles (110) of atomization fluid may show any shape of section, convergent, convergent/divergent or cylindrical. FIGURE 3 illustrates respectively at (111), (112) and (113) for example, a convergent nozzle (111), a divergent nozzle (113), intermediated by a cylindrical section (112), this arrangement not being a limiting aspect of the invention.

The number of side feed nozzles (120) may be one, two or more for each central nozzle (110) of atomization fluid. In FIGURE 2A two side feed nozzles (120) for each central atomization fluid nozzle (110) are shown as an example.

FIGURE 4A illustrates the liquid feed side nozzle (120) having a geometry of convergent orifices, respectively the inlet (121), the inner bevel

(122) and the discharge orifice (123). Such geometry is directed to the least possible loss of charge but is not limiting for feed injection, and may take different shapes such as convergent or cylindrical.

In the present application, where the atomization fluid and the liquid feed flow independently in the riser until they are admixed at the bottom of the mixing chamber (101), the pressure of the atomization fluid is optimized, at the required degree, to promote atomization. Therefore, the loss of charge of the liquid feed circuit or drop in static pressure may be varied without restriction in order to be adapted to the local conditions of its application. The static pressure drop may in principle be varied between 1 and 10 bar, preferably between 1.5 to 5 bars, still more preferably between 2 and 3.5 bar. On the other side, the pressure drop of the atomization fluid may vary between 2 and 20 bar, preferably between 3 to 15 bar, and more preferably between 5 and 10 bar. Any combination of said loss of charge for the two fluids might be employed without departing from the scope of the invention.

A detail of the atomization fluid nozzle (110) in FIGURE 3, is its beveled finishing. In the case when convergent/divergent or only convergent nozzles are used, the edges of the convergent section (111) may have inclination angles between 30° and 120°, preferably between 40° and 90°, more preferably between 50° and 80°. The divergent section (113) may also be at an angle of between zero and 90°, preferably, from 5° to 30°, more preferably from 6° to 14°. The leveled straight finishing is not a limiting aspect of the invention and may even show concordance rays or, as is known by the experts, sweetening rays.

As mentioned before, the number of central atomization nozzles (110) may vary, as a function of the flow rate of the atomization fluid. The preferred modes of the invention consider a number of nozzles (110) that may vary between 1 and 12, preferably 4 to 9, and more preferably 3 to 7 nozzles (110).

The number of side nozzles (120) for liquid feed shown in FIGURE 2 for the feed outlet as mentioned hereinbefore, is equal or higher than the number of central nozzles (110) for atomization fluid. According to the mode shown in the FIGURES, the number of liquid feed side nozzles (120) is 6, distributed according to the rate of 2 feed nozzles (120) for each atomization fluid nozzle

(110). As described before, this number is only an example, and may be varied without being a limiting aspect of the invention.

According to FIGURE 3 and as usually found in the art, the sealing between the body (102) of the atomization unit (100) and the outer conduit (300) is made by grooves known by the experts as "labyrinth" and are indicated by numeral (104). Such grooves, specifically dimensioned in the usual way, assure the sealing of the atomization unit (100) with the conduit (300) through which the liquid feed flows.

According to FIGURE 2A, the combination of the flows of feed and atomization fluid provides the prompt atomization of the liquid stream and generates a spray, a universe of droplets in a mixing chamber (101) designed so as to avoid the coalescence of the feed droplets freshly dispersed by the atomization fluid.

Chamber (101) is an open space where the liquid jets from the side feed nozzles (120) and already atomized by the high speed jets of the already atomized atomization fluid are admixed to form a homogeneous spray having a fan-like shape. FIGURE 2B illustrates the mixing chamber (101) in a top view having the shape of a rectangular slit. This kind of slit is only an example, since the opening of the discharge of the mixing chamber (101) may have several shapes, including round shapes, this not constituting a limiting aspect of the invention.

An important parameter related to the mixing chamber (101) is the dimensional ratio L1/L2 between, respectively, the length and the width of the bottom of the chamber (see FIGURE 2A). According to preferred embodiments of the feed-dispersion system of the invention, the dimensional ratios L1/L2 are comprised in the range of from 0.5 to 20, more preferably between 1 and 10, still more preferably between 2 and 7.

The mixing chamber (101) entails two characteristic opening angles, respectively, β shown in FIGURE 2 and α, shown in FIGURE 3.

Angle α is the opening angle of the mixing chamber, as measured in the plane of the atomization fluid nozzles (110).

Angle β is the characteristic angle of the opening of the mixing chamber (101), measured perpendicularly to the plane of atomization nozzles.

A variation in α and β leads to the creation of several possible openings of the mixing chamber (101). According to the preferred mode angle α may vary between 5 and 90°, preferably in the range of from 10° to 60°, α being a function of the number of nozzles (110). Accordingly, angle β may vary between zero and 20°, preferably in the range of from 1° to 12°.

As for the shape taken by mixing chamber (101), as illustrated in FIGURES 4A and 4B, it can vary between the curved surfaces (FIGURE 4A) and up to a prism shape (FIGURE 4B). A preferred however not limiting format is a frustum of a pyramid with the two featured angles α and β being perpendicular one to the other.

As is well known by the experts, the flow of the atomizing fluid transfers high rates of momentum and energy to the flow of feed. Therefore, the quick acceleration makes the liquid feed unstable, this generating unstable ligaments that give origins to drops and finally to the droplets of the atomized spray. Ligaments are liquid portions of the feed, rendered unstable by the high transfer rate of momentum conveyed by the atomization fluid. The ligaments are the precursors of the atomized hydrocarbon droplets. Particularly, the feed-dispersion system as suggested by the present invention bears a geometry that provides for the transfer of momentum and energy in highly efficient form, so as to minimize losses and reaching small average diameters in the spray droplets.

The atomization reached by the feed-dispersion system according to the present invention makes it possible that a jet of feed droplets is formed. This concept leads to excellent results in the conversion profile of a hydrocarbon feed submitted to a fluid catalytic cracking process. Such results result from the generation of a universe of droplets having statistical average diameter and flow rate mass distribution suitable for a perfect interaction with the catalyst.

The present system provides further the advantages consequent on low feed losses attributed to the flow of atomizing fluid and liquid feed, thus allowing lower pumping powers and lower requirements as regards the thermodynamic properties of the atomizing fluid.

The improvement of the present system may be evaluated based on the Example below, where the main conversion parameters for a same feed

cracked by means of a state-of-the-art dispersion system and by means of the feed-dispersion system of the invention are compared.

EXAMPLE

TABLE 1 below presents the comparison between the performance of two feed-dispersion systems: a conventional one, adopted as the state-of-the-art control and another one a prototype of the present invention, the object of the present application. The tests were run in a FCC unit of a large Brazilian refinery, the feed features and operation conditions being kept constant. The results show an increase in conversion of valuable fractions, particularly the cracked naphtha, with an increase of 3.08%. Further, there is a reduction in coke generation (9.46%) and fuel gas (15.65%), which agree with the mass and conversion balance. The numbers show the dependence between the quality of charge injection obtained from the device of the invention and the yields of the catalytic cracking unit (FCC).

TABLE 1

Feed and conversion features	Test 1 (control)	Test 2 Invention	Difference
Feed (m^3/d)	9117	9115	-2
D20/4	0.9418	0.9403	
RCR (%w)	1.79	1.26	
RTX (°C)	540	541	+1
CFT(°C)	273	243	-30
DPT (°C)	727	709	-18
C/O	5.57	6.40	
Product Yields(%w)			
Combined Gas	6.77	5.71	- 1.06
LPG	12.55	12.90	+ 0.35
Cracked Naphtha	43.41	46.49	+ 3.08
LCO	15.61	14.38	- 1.23

DO	15.31	14.78	- 0.53
Coke	6.34	5.74	- 0.60
App. Conversion (%v)	70.46	73.24	+ 2.78
Corrected. App. Conversion. (%v)	71.31	73.65	+ 2.34
Neat Conversion (%v)	87.19	88.55	+ 1.36
Naphtha Quality			
MON	80.1	81.0	+ 0.9
RON	94.1	95.5	+ 1.4

Where:

D20/4 is the product's density at 20°C based on the density of water at 4°C

RCR is the Ramsbottom Carbon Residue

RTX is the Reaction Temperature as measured on the top of the riser

CFT is Combined Feed Temperature

DPT is the regenerator temperature in the dense phase

C/O is the catalyst/oil ratio

LCO is Light Cycle Oil

App. Conversion is the Apparent Conversion

MON is the Motor Octane Number

RON is the Research Octane Number

CLAIMS

1. A feed dispersion system for fluid catalytic cracking units (FCC) for introducing a liquid hydrocarbon feed to a reactor for fluid catalytic cracking, the system comprising:

a feed injection system for supplying hydrocarbon feed to a first nozzle system (120) and for supplying atomization fluid to a second nozzle system (110);

an atomizing unit (100) for atomizing said hydrocarbon feed with an atomization fluid, said atomizing unit comprising said first (120) and second (110) nozzle systems geometrically arranged to discharge into a mixing chamber (101) so that the energy of said atomization fluid is transferred to said hydrocarbon feed.

2. A feed dispersion system according to claim 1, wherein said first nozzle system (120) discharges hydrocarbon feed substantially in a radial direction and said second nozzle system (110) discharges atomization fluid substantially in a longitudinal direction.

3. A feed dispersion system according to claim 2, wherein said first nozzle system comprises a row of nozzles formed in the circumferential side wall of said mixing chamber (101).

4. A feed dispersion system according to claim 2 or 3, wherein said second nozzle system (110) comprises a row of nozzles formed in the longitudinally bottom wall of said mixing chamber (101).

5. A feed dispersion system according to any one of claims 1 to 4, wherein said feed injection system comprises an inner conduit (200), and an outer conduit (300) concentric to said inner conduit (200), said inner conduit (200) for supplying atomization fluid to said second nozzle system (110) and said outer conduit (300) for supplying hydrocarbon feed to said first nozzle system (120).

6. A feed dispersion system according to claim 5, wherein said inner and outer conduits are of substantially circular cross-section and said hydrocarbon feed is arranged to flow through the annular space (210) formed by the outer surface of the inner conduit (200) and the inner surface of the outer conduit (300).

7. A feed-dispersion system according any one of the preceding claims, wherein the liquid hydrocarbon feed is a light gasoil, a heavy gasoil or an atmospheric residue, alone or admixed.

8. A feed-dispersion system according to any one of the preceding claims, wherein the atomization fluid is an inert gas used between 1 and 5% by weight, preferably 2 and 4% by weight, based on the weight of the feed.

9. A feed-dispersion system according to claim 8, wherein the inert gas is steam.

10. A feed-dispersion system according to any one of the preceding claims, wherein for each nozzle of said second nozzle system (110), there is at least one nozzle of said first nozzle system (120).

11. A feed-dispersion system according to claim 10, wherein for each nozzle of said second nozzle system there are at least two nozzles of said first nozzle system (120).

12. A feed-dispersion system according to any one of the preceding claims, wherein the number of nozzles in said second nozzle system (110) varies between 1 to 12, preferably between 4 to 9, more preferably from 3 to 7.

13. A feed-dispersion system according to claim 5 or 6, wherein the symmetry axes of the nozzles of said second nozzle system (110) are substantially parallel to the symmetry axes of the inner/outer conduits (200, 300).

14. A feed-dispersion system according to claim 5 or 6, wherein the symmetry axes of the nozzles of said second nozzle system (110) are substantially non-parallel to the symmetry axes of the inner/outer conduits (200, 300).

15. A feed-dispersion system according to claim 5 or 6, wherein the symmetry axes of the nozzles of said first nozzle system (120) are substantially perpendicular to the symmetry axes of the inner/outer conduits (200, 300).

16. A feed-dispersion system according to any one of the preceding claims , wherein the mixing chamber (101) has a circumferential sidewall length L1 and a longitudinally bottom wall width of L2, the dimensional relationship L1/L2 being in the range of from 0.5 to 20, preferably 1 to 10, more preferably of from 2 to 7.

17. A feed-dispersion system according to any one of the preceding claims, wherein the mixing chamber (101) has an opening angle α, measured in the plane of the second system of nozzles (110).

18. A feed-dispersion system according to claim 17, wherein the opening angle α varies between 5° and 90°, preferably in the range of 10° to 60°, α increasing with the number of nozzles in said second system of nozzles (110).

19. A feed-dispersion system according to any one of the preceding claims, wherein the mixing chamber (101) has an opening angle β, measured perpendicularly to the plane of the second system of fluid nozzles (110).

20. A feed-dispersion system according to claim 19, wherein the opening angle β of chamber (101) varies between zero and 20°, preferably between 1 and 12°.

21. A feed-dispersion system according to any one of the preceding claims,

wherein at least one of the nozzles of said second system of nozzles (110) is cylindrical.

22. A feed-dispersion system according to any one of claims 1 to 20, wherein at least one of the nozzles of said second system of nozzles (110) is convergent.

23. A feed-dispersion system according to any one of claims 1 to 20, wherein at least one of the nozzles of said second system of nozzles (110) is convergent/divergent.

24. A feed-dispersion system according to claim 23, wherein the edges of the converging section (111) of said at least one nozzle comprise sloping angles between 30 and 120°, preferably between 40° and 90°, more preferably between 50° and 80° while the diverging section (113) comprises angles from zero to 90°, preferably from 5 to 30°, more preferably from 6° to 14°.

25. A feed-dispersion system according to any one of the preceding claims, wherein at least one of the nozzles of said first system of nozzles (110) is cylindrical.

26. A feed-dispersion system according to any one of the preceding claims, wherein at least one of the nozzles of said first system of nozzles (110) is convergent.

27. A feed-dispersion system according to any one of claims 1 to 24, wherein at least one of the nozzles of said first system of nozzles (110) comprises an inlet (121), an inner bevel (122) and a discharge orifice (123).

28. A fluid catalytic cracker comprising:

2, 4, 6 or more of the system according to any one of the preceding claims radially coupled to a riser at one, two, or more riser levels, at an elevation angle between 30 and 70°.

29. A process for the fluid catalytic cracking of liquid hydrocarbon feeds

under conditions of fluid catalytic cracking fluids and in the absence of added hydrogen, wherein the process is carried out by means of apparatus according to any one of the preceding claims.

30. A method of atomizing a hydrocarbon feed comprising:

supplying hydrocarbon feed to a first nozzle system (120);

supplying atomization fluid to a second nozzle system (110);

accelerating the flow of atomization fluid into a mixing chamber (101) using said second nozzle system (110);

accelerating the flow of hydrocarbon feed into a mixing chamber (101) using said first nozzle system (120);

mixing said accelerated flows so as to transfer energy from said atomization fluid to said hydrocarbon feed and thereby atomize said hydrocarbon feed.

FIG. 1

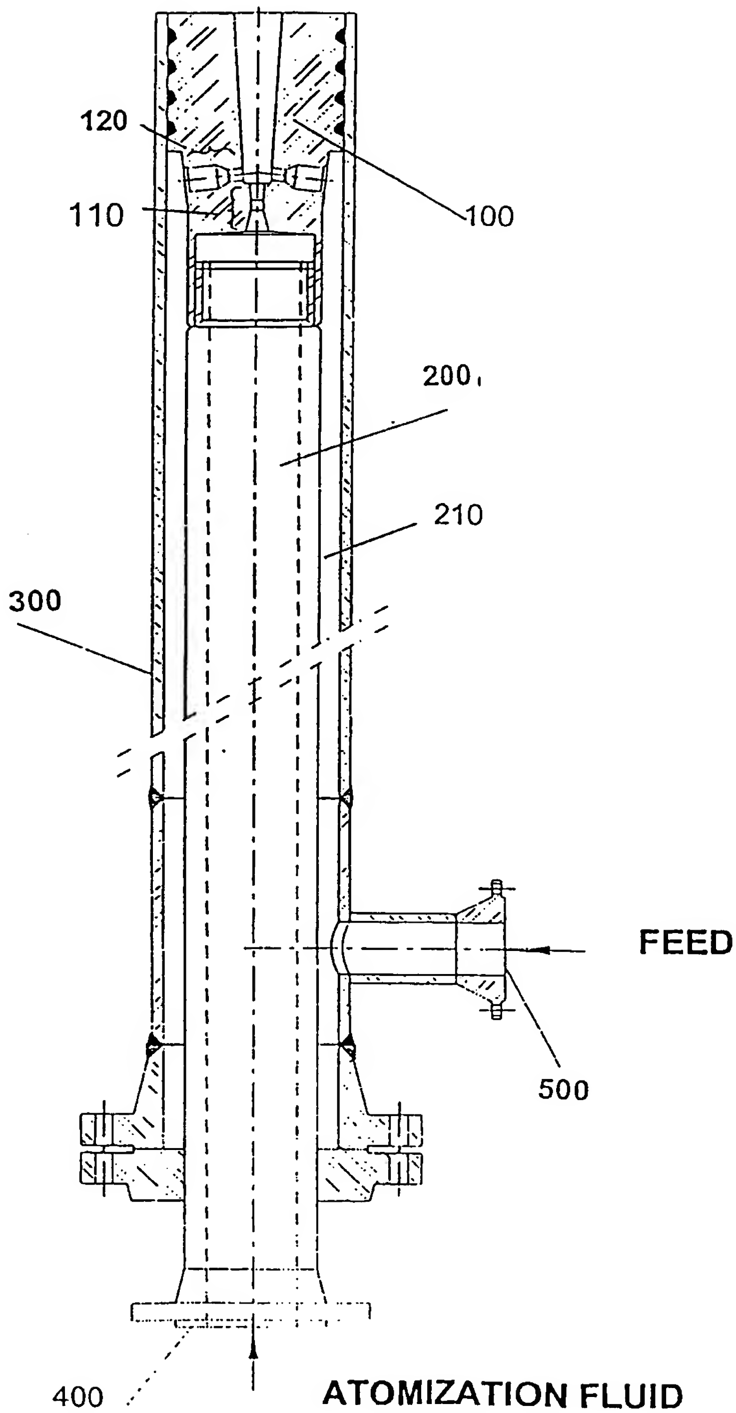
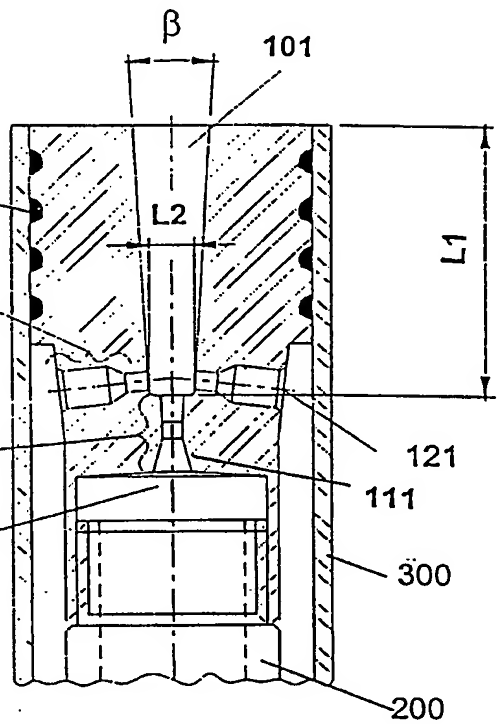


FIG. 2

FIG. 2A



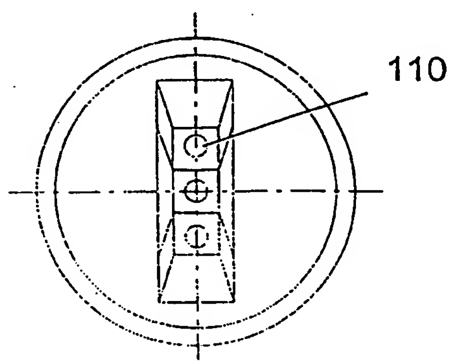


FIG. 2B

FIG. 3

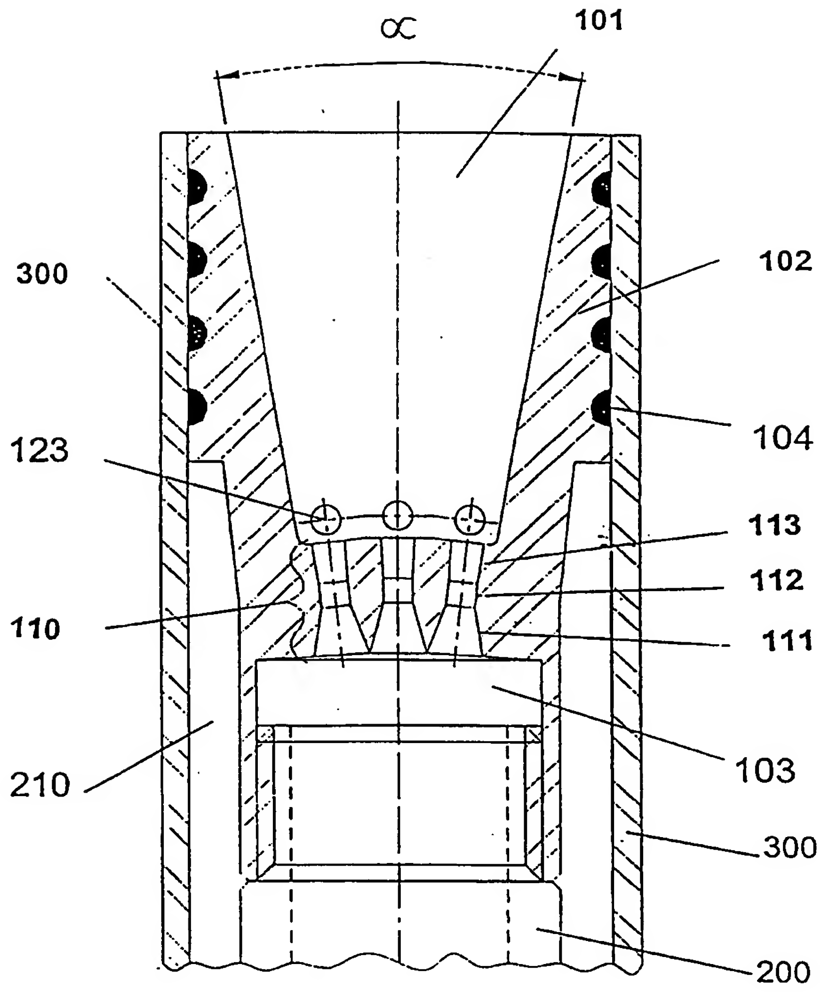


FIG. 4

FIG. 4A

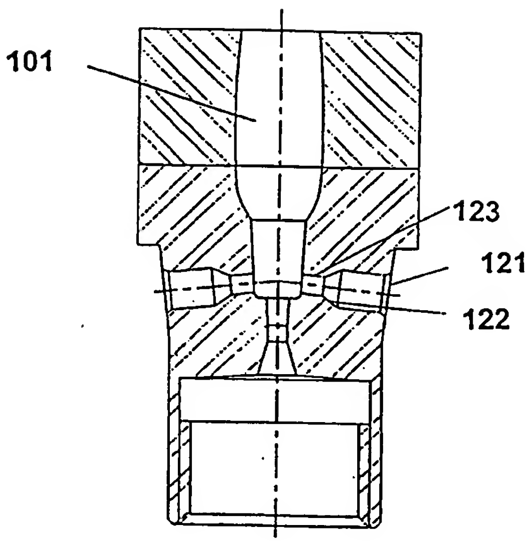


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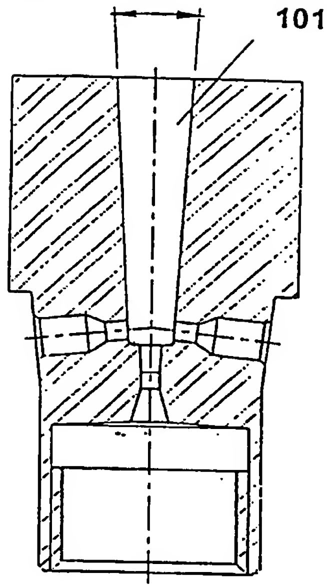
FIG. 4B



STRAIGHT

INTERNATIONAL SEARCH REPORT

International Application No
PCT/BR 00/00135

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C10G11/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C10G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 5 554 341 A (WELLS JAN W ET AL) 10 September 1996 (1996-09-10) the whole document	1-30

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
23 March 2001	30/03/2001

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
PCT/BR 00/00135

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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